January 21, 2000
Permit No. TA001RE

Work Plan for:
Surface Erosion and Slope Stability
Mine Site
Molycorp, Inc. - Questa Division

## 1. Background, Rational, Objectives and Timing

### 1.1 Background

On December 30, 1999 the New Mexico Mining and Minerals Division approved an extension for approval of the closeout plan for the Questa mine site area. The extension included tasks yet to be completed. The Surface Erosion and Stability Work Plan was originally due December 31, 1999 and is currently due January 21, 2000.

This plan address three areas of the mine: the mine rock piles, the open pit and the cave zone.

i) Mine rock piles

The overburden/waste rock piles were initiated in 1964 and the last placement was approximately 1983. Approximately 320 million tons of mine rock was placed in a series of piles that are tiered against the mountain slopes surrounding the open pit in the upper reaches of Capulin Canyon, Goathill Gulch, Sulphur and Spring Gulches and on the north slope of the Red River. The piles are of various forms ranging through valley fills (Sulphur and Spring Gulch), valley head fills (Capulin Canyon), and side hill fills (Goathill Gulch and Red River slopes). The highest cascades of piles extend from about elevation 9,700 ft to the Red River valley at 8,000 ft

Construction of the piles followed standard mining practices at the time. The piles were constructed in lifts created by end dumping over the pile crests. This method of construction results in pile slopes being at their angle of repose between berms or benches. The sequence of pile lift construction was generally from the top down as the open pit mining progressed to ever increasing depths. The lower piles were therefore constructed principally as 'wrap around' berms. Bench surfaces were compacted by heavy equipment and trucks.

Proposed future underground mining will result in some cave zone formation under mine rock piles in Goathill Gulch.



While no significant mass movement (instability) has been experienced in the piles, and erosion has been confined to relatively shallow surface erosion contained by the installed erosion control structures, it is necessary to evaluate the stability overall and long term stability of the piles as well as the surface erosion potential in order to design long term control and closeout measures.

ii) Open pit

The open pit has maximum slope heights of about 1500 ft and has, in common with mining practice at the time of mining, been mined to limiting equilibrium such that parts of the pit slopes (primarily the west slopes) have failed. The lower part of the pit intersects the old mine workings and water is drained from the base of the pit into these workings. The Southwest and Northeast ore bodies are contiguous with the ore body that was mined in the open pit. Future mining of these remaining ore bodies is anticipated to be by open pit methods for the Northeast ore body and by underground caving methods for the Southwest and additional areas of the Northeast ore body. The northwest slopes of the pit will be modified by the additional open pit mining and both the northwest and southwest slopes will be effected by the zone of influence of the caving zones for the underground mines.

iii) Cave Zone

The active mining currently proceeding is causing the formation of a subsidence 'cave zone'. The future underground mining of the Southwest and Northeast ore bodies will result the expansion of the cave zone over these mining areas. The maximum extent of the cave zone is defined by the crack lines shown on Figure 2 of the Closeout Plan submitted to MMD on January 31, 1996.

1.2. Rationale:

The Surface Erosion and Slope Stability investigation and analysis at the mine for the open pit, cave zone and site mine rock piles will be conducted to ensure that long-term stability conditions can be achieved in a manner suited to such structures and to maintain human health and safety, and that conditions will be achieved to create a self-sustaining ecosystem upon final closure.

1.3 Objectives:

The objectives of the surface erosion and stability analyses are to:

- Perform site investigation and testing to the extent necessary to augment existing information to determine the shear strength of mine rock and

foundation soils, as well as pore water pressure which would effect the long term stability of the open pit, mine rock piles and cave zones.

- Analyze and predict the stability and future performance of these structures to the extent necessary for the development and demonstration of adequacy of remediation and closeout measures.

- Perform field reconnaissance surveys of the erosion conditions, and potential conditions applicable the surface's of each of these structures to determine current erosion conditions and potential.

- Evaluate alternative erosion control measures for remediation and the Closeout Plan.

1.4 Timing:

The work plan is submitted January 21, 2000 with a 30 day review and revision period. The work will take place from March 1 to July 15, 2000 with the report submitted August 16, 2000. The revised Closeout plan is to be submitted January 31, 2001 and will use this information in the development of the revision.

## 2. **Scope of work**:

2.1. Evaluation of the waste rock piles

i) Surface erosion:

a) Previous data will be evaluated to determine potential areas of concern regarding erosion at the site. The main source of data to be used will be the SRK data (in Chapter 4 of the Revegetation Plan in the Closeout Plan submitted January 1996). This data was collected across the mine in 1994.
b) Visual surveys will be performed in March (as weather allows) and where possible will be correlated with the 1994 SRK data to do a preliminary evaluation of changes over time. Additional areas with potential for problems will be noted.
c) Visual surveys will include enumeration of vegetation on the plots as well as condition of vegetation on the plots. The status of established vegetation will also be used as a measure of visible erosion.
d) Based on the data evaluation and the surveys, areas will be selected for establishing test plots to measure erosion. All the dumps will be represented by at least one test plot. Test plot locations will be confirmed in the field and may be adjusted to allow for safe access. Potential locations for the test plots will be discussed with MMD prior to installation. Because of the time frame for data collection and the

report due date, test plots will need to be set up by the middle of April, 2000 to capture any snow melt conditions as well as the initial summer rainfall events. Depending on the summer rainfall initiation supplemental data will be added to the report at the end of November 2000 to allow for data collection through October.

e) The Revised Universal Soil Loss Equation (RUSLE 1.06) for mined lands, construction sites and reclaimed lands, as well as other erosion estimation methods (such as the techniques developed by S.R. Abt, M.S. Khattak, M.S. Nelson and others) will be evaluated for their appropriate use in predicting soil erosion at the mine site. Where possible, this model will be used as part of the evaluation process. Inputs will be based on actual site conditions and these will be enumerated in the report.

f) Alternative methods for the control of surface erosion will be evaluated. These will include but not be limited to: use of hard durable rock armoring or rip-rap, resloping, drainage management on slopes (shorter slope lengths and drainage berms), and revegetation.

ii) Slope Stability:

The slope stability investigations and analyses will be coordinated with the geochemical characterization studies for the mine rock piles. Tasks will include:

a) Evaluation of geochemical characteristics of waste rock piles (dependent upon completion of Task A.1.5, 1.6 and 1.7), and the weathering and change of material properties with time.

b) Evaluation of geotechnical characteristics of waste rock piles. Samples of the various mine rock types will be selected from the drilling performed for the mine rock pile characterization and submitted for laboratory testing for grading, shear strength, permeability and slake durability. Such testing is currently being performed, and the protocols are defined, for the cover materials evaluations for the mine rock piles. Allowance is made in this study program for the collection of four more representative waste rock samples and conductance of similar suites of testing. The testing wil be performed as part of the Phase 2 Rock Pile Geochemical Characterization Program.

c) Evaluation of waste rock pile geometry and composition will be performed based on historic mining records and available survey data. This information will be used to define the geometry for slope stability analyses.

d) Evaluation of foundation soils conditions will be done based on the information obtained from soil exposures on the site, logging of the Phase 2 geochemical characterization holes where they penetrate into foundation soils below the piles, review of the logs from the water quality monitoring

holes drilled at the base of the piles and interpretation of pre-mining air photo's. Allowance is made for making up to four test pits at various representative locations on the site to sample foundation soils for laboratory shear testing.

e) The appropriate seismic acceleration design values for the site will be determined based on the historic seismic record for North America.

f) Using the information from the above program, Minimum Factor of Safety (FOS) calculations will be made for all existing slopes using accepted stability analysis codes such as SLOPEW, including: block failure, static; block failure, pseudo-dynamic; circular failure, static; circular failure, pseudo-dynamic. Where appropriate, calculations will be made of displacement that may be expected under dynamic (earthquake) loading using Newmark's method.

g) Alternative stabilization measures, as well as the consequence of failure, where failure could occur will also be investigated. The results of the investigations and analyses will be provided in the report to be submitted August 16.

2.2 Evaluation of the open pit

The open pit is undergoing severe erosion on all walls except the south slope. A large failure has occurred and continues to progress on the west wall. All erosion and slump materials from the pit slopes are contained in the base of the pit.

The evaluation of the erosion conditions in the pit will comprise the following:

- A reconnaissance survey and characterization (similar to the rock piles) of all the pit walls.

- Estimates of the on-going rates of erosion and the long term performance of the pit slopes.

- Evaluation of the cost and benefit of any remediation measures (if any) that may be applicable to erosion control. Revegetation potential and considerations will be included in this evaluation. The pit slope materials are similar to the mine rock materials hence the work for the latter will be directly applicable to the former.

The evaluation of the pit wall stability will comprise:

- A review and summary of the geotechnical information slope stability investigations and analyses performed for the original open pit design and operation.

- A review and summary of the pit slope performance during mining.

- Based on the information obtained from above an assessment will be made of the likely long term performance of the pit slopes in the absence of any additional mining.

- The change in slope stability conditions resulting from additional open pit mining of the ore in the northwest wall will only be done when the detailed mine design is done for permitting.

- The effect on pit slope stability of the underground mining of both the Southwest and Northeast ore bodies will be evaluated to assess the likely performance of the affected slopes and the consequences for the Closeout Plan and remediation measures.

- Alternative measures for ensuring the health and safety of the public and for remediation and Closeout will be evaluated, including the effects of partial or complete pit backfilling.

- The results of the studies will be documented and submitted in the Report by August 16, 2000.

## 2.3 Evaluation of cave zone

The cave zones are still forming as mining progresses. Current experience with the cave zone surface deformations is that a great proportion of the vegetation on the pre-slump surfaces survive the subsidence and continue to flourish. The existing cave and vegetation conditions therefore provide an excellent 'test plot' of likely future conditions.

With regard to erosion, studies for the cave zones will be limited to an assessment of the likely flow patterns and erosion conditions that will develop. All eroded materials will be contained in the caves which will drain to the underground. They will therefore not be a source of surface water sediment load to the environment. A survey will be made of the condition of vegetation in subsided zone to determine the changes that occur and to allow a prediction to be made of the nature and potential of self sustaining ecosystem maintenance in the slumped zones.

With regard to stability, the rock mechanics data used for mine design, cave geometry determination and crackline prediction will be reviewed and summarized. A re-evaluation will be made of the likely long term shape of the slumped surface on mine closure. Alternative methods for ensuring human health and safety will be evaluated. Alternative methods for minimizing impacts

of subsidence and improving vegetation development will be evaluated. The results of the studies will be documented and submitted in the Report by August 16, 2000.